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THE TIN DEPOSITS OF THE MALAY PENINSULA WITH SPECIAL REFERENCE TO THOSE OF THE KINTA DISTRICT.

CONTENTS.

Geographic position of the Malay tin regions.—The Malay Peninsula is the southeastern extremity of the continent of Asia. It extends from about latitude 14° N. in a southerly and southeastern direction to about latitude 1° 20′ N., and still farther south a chain of islands connects it with the main part of the Australasian archipelago. It is a narrow strip of land about 900 miles in length and from less than 50 miles to over 150 miles in width.

The northern and central parts of the peninsula belong to Siam, though the British possessions of Burma include some of the northwestern part. The southern part of the peninsula is comprised mostly in the native states of Perak, Pahang, Selangor, Negri Sembilan, and Johor, ruled by independent sultans, but

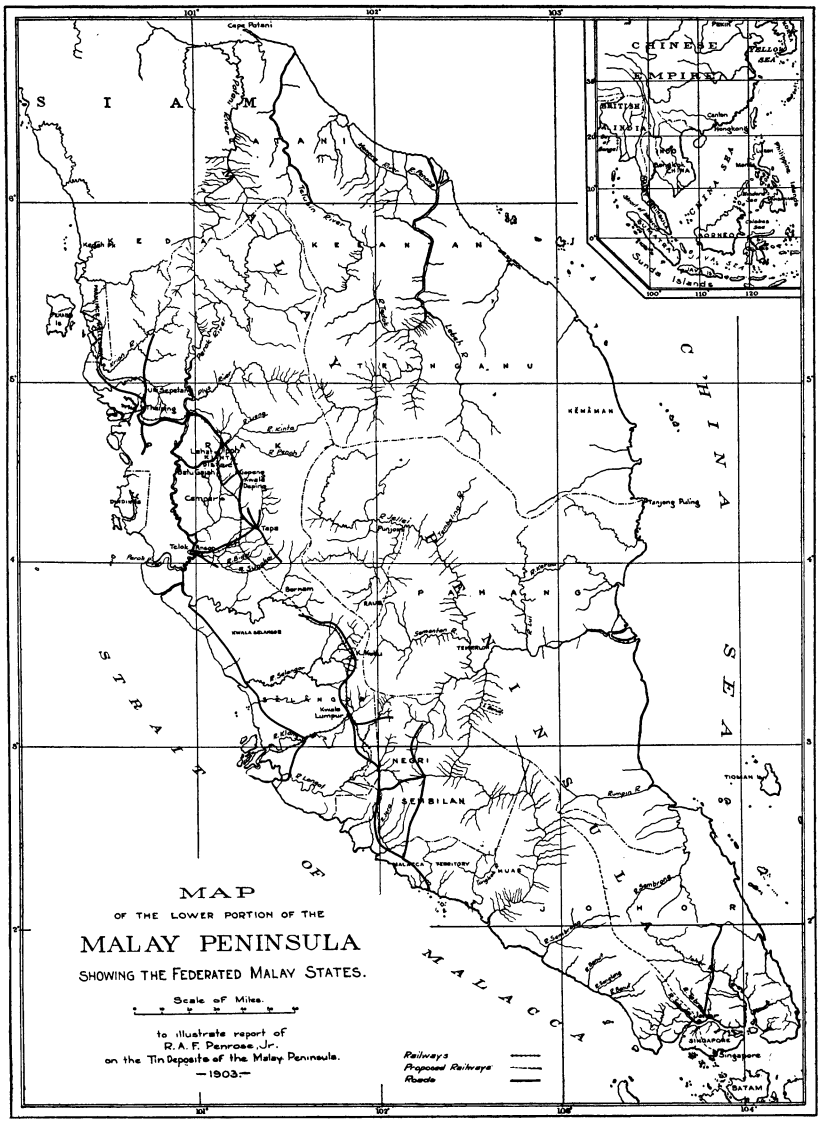


FIG. 1.—Map of lower part of Malay peninsula showing Federated Malay States.

more or less under British influence. These principalities have recently combined under the name of the Federated Malay States. Along the lower coast of the peninsula the British own certain small strips of land and islands, including Province Wellesley, Dindings, and the Malacca Territory on the mainland, and the islands of Penang, Pangkor, and Singapore. These, together with several other islands, represent what are known as the Strait Settlements. The Federated Malay States at present comprise most of the tin regions worked on the peninsula.

The tin deposits occur in greater or less quantities from the state of Johor in the southern extremity of the peninsula, northward to the limit of the state of Perak on the Siamese border, a distance of some 350 miles. To the north of this limit in Siam, even beyond the high peak of Mount Kedah, tin has been reported, but the deposits have not been much explored, and no very prominent mines have been opened. This may possibly be due to the unexplored character of the Siamese part of the peninsula, as the roads are not so good as in the Federated Malay States, and travel and exploration are very difficult in the dense jungle. Even in the Malay states, though the tin is found over a large area, most of the production comes from a few places. By far the larger part of it is mined in the states of Perak and Selangor, while very little has been found in Johor, and the production of Pahang and Negri Sembilan is small.

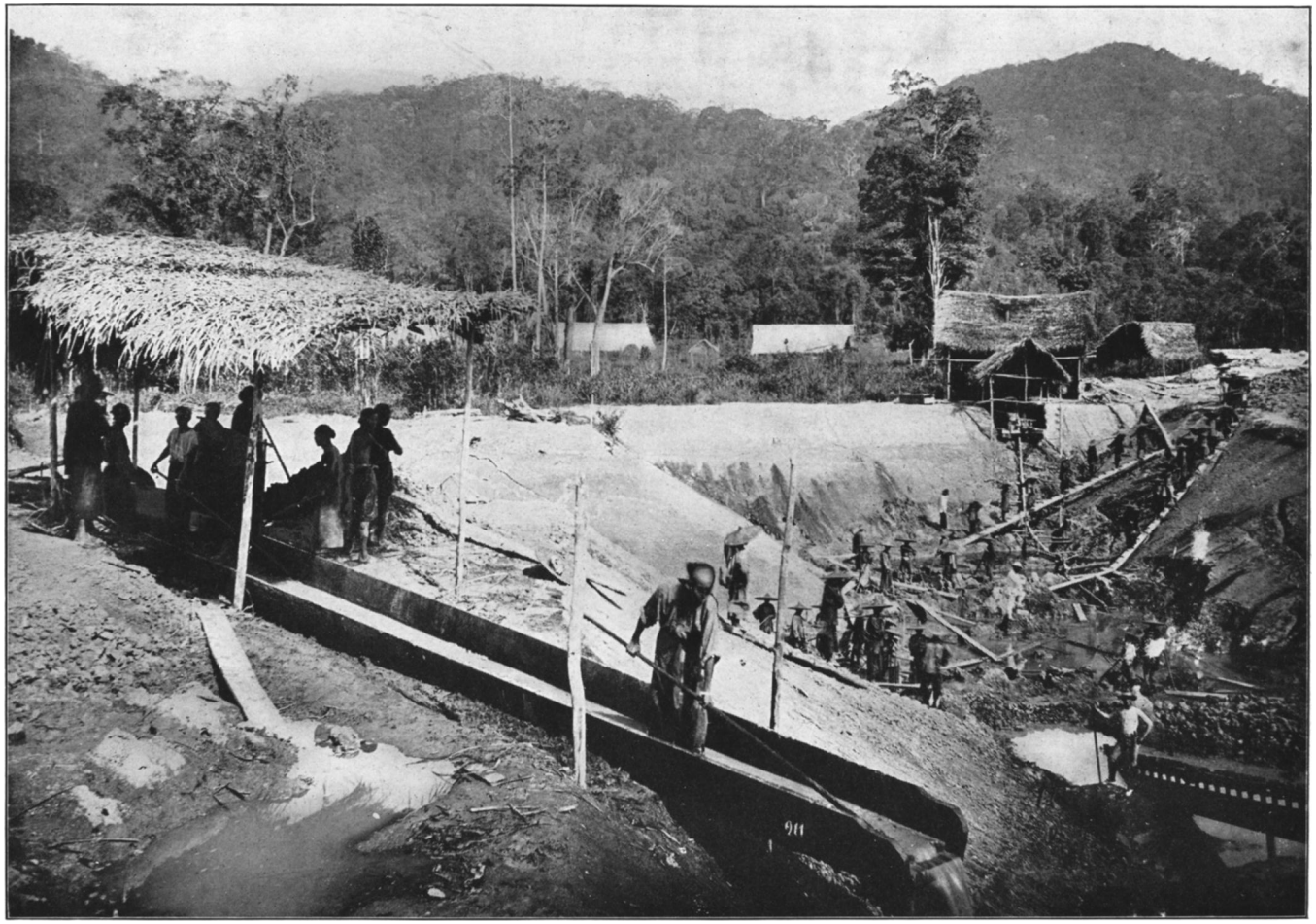
Perak is the largest producer of the Malay states, supplying considerably over half of the tin of the peninsula, and the Kinta district is at present the most important tin locality in that state, though tin is also mined at Thaiping and other places. In Selangor the most important mining center is Kwala Lumpur, and the production of this region is second only to that of the Kinta district. Besides the places already mentioned, many other smaller tin districts exist, and, in fact, most all of the numerous small native towns on the west slope of the peninsula are largely dependent on the tin industry.

Most of the tin regions are on the western side of the mountains which form the backbone of the peninsula. On the eastern side very little tin is found. On the other hand, a considerable

amount of gold occurs on the eastern side, while very little has been found on the western side. Hence the eastern slope is known as the "gold region" and the western slope as the "tin region."

To the southeast of the peninsula, tin is mined on the islands of Banka and Billiton, which are owned by the Dutch. In Banka the mines are worked by the government and are more productive than those of Billiton, which are operated by an independent company. The occurrence of the tin on these islands is said to be similar to that on the peninsula. Tin is found also on the island of Sumatra, off the southwest coast of the Malay peninsula, but has not been worked to any great extent. Its occurrence is said to be somewhat like that of the peninsula, and the fact that the production is small is said to be due to the unexplored character of the country and to the constant troubles between the Dutch authorities and the natives.

General geology of the Malay tin regions.—The Malay peninsula consists of a central axis of rugged mountains, with occasional subordinate parallel or diverging axes and isolated peaks. The whole region is covered by a jungle of tropical vegetation so dense that the roads and trails have to be hewn through it with an ax. In the tin regions the main range is composed of granitic rocks, occasionally intersected by feldspathic and other dikes, while in places are found gneissic and schistose rocks, with occasional areas of a white, highly crystalline limestone. The granite is mostly of a gray color and is composed of quartz, feldspar, and biotite or hornblende, or both. There seem to be all gradations from a granite with biotite and no hornblende to a granite with hornblende and no biotite. Black tourmaline is a common constituent of the granite in the neighborhood of the tin deposits. The limestone is generally a highly crystalline marble of a white color, occasionally streaked or spotted with gray. No fossils were seen in it, and it is said that none have been found. Such as may have existed seem to have been destroyed by the metamorphosis of the rock, though a more thorough search might reveal traces of them. The limestone is especially abundant in the Kinta district, though also found



Mining and washing tin ore near Ipoh, Perak, Malay peninsula.

elsewhere on the peninsula. Occasionally strata of a fine-grained, friable sandstone occur on the lower slopes of the mountains, which appear to be younger than any of the other rocks mentioned. The granitic rocks and limestone, however, are the formations most commonly seen in the few places where any rocks appear through the soil.

All the rocks, especially those of a granitic nature, are much

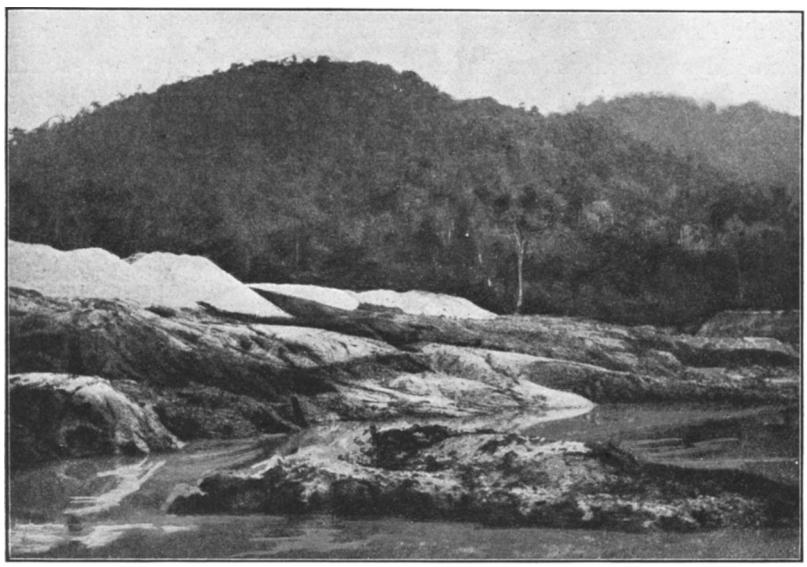


FIG. 2.—Tin diggings in the alluvium at foot of granitic hills, Kinta district, Perak, Malay peninsula.

decayed, often to a depth of many feet, and the detritus from them has formed large areas of alluvium in the mountain valleys and along the lowlands on the coast. Much of this alluvium contains more or less oxide of tin or cassiterite in particles and fragments of varying size, forming what might be termed "tin placers," and it is from these deposits that the mass of the tin of the Malay peninsula is derived. Tin also occurs in the granitic rocks and limestone, as will be more fully described farther on, but though these rocks were doubtless the source of the alluvial tin, yet the ore in them is at present worked to only a very small extent.

Location of the Kinta district.—The tin region most carefully examined by the writer was the Kinta district in Perak, and this will therefore be described more in detail than the other districts mentioned. The Kinta district has no definite boundaries, but the name is a general term applied to an area in the southern part of the state of Perak, in the valley of the Kinta river. This stream is a branch of the Perak river which flows through the state of the same name into the Strait of Malacca below Teluk Anson. The Kinta district comprises a more or less inclosed valley about 40 miles in length in a north-and-south direction, about 30 miles in width at its south end, and about 5 miles at its north end. To the east is the high granitic range, forming the backbone of the peninsula and rising in some places about 8,000 feet above the sea ; to the west is a lower granitic range, rising some 3,000 feet and separating the valley from the Strait of Malacca. Between these ranges are lower mountains and areas of limestone, surrounded and partly covered with great tracts of alluvium. Twenty years ago the Kinta district was almost unknown, and Thaiping and Kwala Lumpur were the great tin centers, but now it is the most important district on the peninsula. It is intersected from north to south by a railway which is being extended at both ends. Among some of the more important mining centers in the district are Campar, Gopeng, Batu Gajah, Tronoh, Cacha, Lalang, Papan, Lahat, Chongkat Pari, and Ipoh, the last being the commercial center of the district; in fact, the alluvium over large areas has been completely stripped from the bed-rock in search of tin, and has been overturned in great piles, leaving the once fertile soil in a condition of desolation similar to the old gold placer diggings in parts of California.

Mode of occurrence of the alluvial tin in the Kinta district.—Most of the tin ore of the Kinta district is derived from alluvial deposits varying in character according to the nature of the rocks from which they have been derived and the distance to which they have been transported. In the larger valleys where the detritus from areas of different rocks has been mixed, the alluvium is commonly composed of a heterogeneous mass of

Tin mine of Mr. Foo Choo Choon, Tronoh, Perak, Malay peninsula.

white, gray, or red sandy or gravelly clay, often of a mottled character, containing numerous small quartz fragments about the size of a pea, derived probably from the decay of granite and in part from quartz veins, together with pebbles and bowlders of granite, gneiss, schist, pegmatite, limestone, etc. The alluvium in the hills, however, nearer its source, varies more in character, distinctly reflecting, in different places, the nature of the different rocks from which it has been derived. Frequently the alluvium is much stained with iron, and carries layers and masses of rusty ferruginous material consisting partly of sand cemented by iron, and partly of masses of granite and quartz with iron pyrites rapidly oxidizing and forming a brown mass. Sometimes the alluvium contains large quantities of vegetable remains and partly lignitized wood.

The dense tropical vegetation has given rise to large quantities of organic acids in the soil, and these have often leached the iron from the tin alluvium, leaving a clear white or gray mass, while in other places not so much exposed to this influence the gravel is still discolored. This is especially true of the upper parts of the deposits, which have often become entirely bleached, while the deeper parts are still heavily impregnated with iron. The waters in most of the mines are heavily charged with iron, which is deposited on the sides of the pits and shafts, showing that chemical action is still very active.

The tin occurs in the alluvium in different ways. Sometimes it is scattered through it from top to bottom in comparatively uniform quantities; sometimes it is in layers of rich ore separated by layers of lean or barren ground; sometimes it is richest on the bed-rock, and at other times higher up in the deposit. As a general rule, however, there is a covering, or "overburden" as it is called, of barren alluvium from 10 to 40 feet or more in thickness, and the tin ground is found beneath this. The best alluvium occurs immediately at the foot of the mountains. Higher up it is often richer, but of small extent, while farther away it is thicker, but of lower grade. The ordinary tin-bearing strata vary from 1 to 30 feet in thickness, though sometimes they reach over 100 feet. At Gopeng, the Gopeng Tin Mining

Co., an English corporation, works alluvium which carries tin from the surface down to a depth of from 5 to 30 feet without any barren "overburden". At Campar, a French company, known as La société d' étan de Perak, has large open pits in the alluvium of the valley of the Campar river, where the tin-bearing stratum varies from 2 to 10 feet in thickness and is overlaid by a

FIG. 3.—Stripping new tin ground south of Campar, Perak, Malay peninsula.

barren "overburden" of about 40 feet in thickness. At Tronoh, in the well-known mine formerly owned by Mr. Foo Choo Choon, but recently sold to an English company, the "overburden" is from 30 to almost 40 feet in thickness, and the tin-bearing ground below has been penetrated by an open pit and an inclined shaft. The incline is about 400 feet long, equal to about 140 feet vertically, and the bottom of the tin ground has not yet been reached. This thickness of tin-bearing alluvium is, however, very exceptional. Many other cases, showing other variations in the conditions of the tin-bearing alluvium, might be cited.

At the bottom of the alluvium is generally either granite or limestone, though frequently where the tin stops, barren alluvium or rock decayed *in situ* separates it from the bed-rock, so that the solid granite or limestone is not always seen. This is especially true in granitic areas where the surface of the rock below the alluvium is often altered to a soft, partly kaolinized mass. Sometimes beds of coarse granite pebbles and bowlders, forming the substratum of the tin alluvium, have decayed *in situ* in the same manner as the surface of the original rock; and it is not uncommon to see rounded granitic fragments converted into a soft putty-like mass, which when broken up gives rise to angular particles of the original quartz of the rock and a soft clay resulting from the decay of the feldspar. Hence angular quartz may often be found in deposits that have been transported long distances. Such an occurrence is seen on the property of the Gopeng Tin Mining Co., where the tin-bearing stratum consists of a more or less ferruginous deposit of sandy and gravelly material occupying a ridge on the side of a small stream and underlaid by a pebbly stratum like that just described. In the creek bed below, near the native town of Gopeng, tin alluvium washed down from the ridges is extensively worked by the Chinese.

The limestone bed-rock is often leached in deep hollows and caves, as seen at Chongkat Pari and near Tronoh (see Figs. 4 and 6), while elsewhere, as seen between Ipoh and Lahat, it forms an undulating surface with alternating protrusions and recessions, following regular lines, probably influenced by lines of bedding, and resulting in a series of natural riffles behind which cassiterite has concentrated. (See Plate IV.) This occurrence is similar to the way gold has collected behind limestone riffles near Columbia, in California, and the country has been stripped in search of ore in much the same way as in the California region. The road from Ipoh to Lahat runs through a broad valley, and the rough surface of the bare limestone bed-rock is seen in many of the old workings.

Tin alluvium frequently occurs on ridges and hills as well as at lower levels in the valleys and creek beds. This sometimes suggests strongly that, since the formation of tin alluvium began,

there has been an elevation of the region followed by subsequent erosion, with the result that the older tin alluvium occupies the higher places, while the younger alluvium, derived probably in part from the older deposits, occupies lower levels, in much the same way as the Tertiary gold placers of California often occupy the higher spots and the more recent placers are found in the present stream beds. This may be true in some of the tin deposits, but it is necessary to distinguish between such occurrences and the cases where the tin deposits on the higher places are simply residual deposits formed *in situ* by the superficial decay of tin-bearing rocks, without removal of the tin from the region of its source.

Nature of the tin ore in the Kinta district.—The tin occurs in the form of cassiterite or oxide of tin (SnO_2), often well crystallized in tetragonal prisms with fine terminations, though the fragments in the alluvium have been more or less rounded by attrition. The ore varies in color from black or brown to gray, grayish-green, white, or transparent, but the commonest kind is of a dark brown or almost black color with a resinous luster. In the mountains, near its source, the ore is angular and in comparatively large fragments, sometimes from an inch to a foot or more in diameter, but this is rare, and farther down hill it becomes more and more rounded and fine-grained, the common alluvial tin fragments ranging from the size of peas to that of sand grains or smaller. In fact, efforts are now being made to work tin ore that exists as a fine powder in the mud banks that line certain parts of the west coast of the peninsula.

The amount of tin in the ore as commercially mined ranges from 69 to 73 per cent., an average of about 70 per cent. being considered very fair. The theoretical amount of tin in cassiterite is 78.6 per cent. The richness of the tin ground varies much in different places. The average value of the alluvium worked in the Kinta district is probably about 1 per cent. of cassiterite, and ground of this grade pays well to work, if favorably situated. If the alluvium contains 2 per cent. of cassiterite, it is considered exceptionally good ground, and with 3 or 4 per cent. it is considered remarkably rich. Sometimes thin strata in the alluvium

are very rich in cassiterite, containing from 40 to 60 per cent., but this is very rare.

Minerals associated with the tin ore in the Kinta district.—With the tin in the alluvium are associated much tourmaline, hornblende, wolframite, and magnetite, while in smaller quantities are found white mica, topaz, scheelite, and sapphire, and it is said that in parts of the peninsula small quantities of thorium and cerium minerals have been found. Some beautiful transparent topaz crystals have been found near Tapa, south of Campar. Gold also has been found in small quantities in the tin alluvium.

It is probable that all these minerals once existed *in situ* in the rock in more or less close association with the tin. Certain other minerals, such as iron pyrites, chalcopyrite, bornite, and arsenical pyrites, which occur with the tin in the rock, are rarely seen in the alluvium, as they have decomposed and mostly disappeared during the erosion of the rock, though rusty masses of these sulphides, partly decomposed, and associated with quartz, often occur in alluvium which has not been transported far from its source.

Occurrence of tin ore in the rocks of the Kinta district.—Though the tin mined on the peninsula comes practically all from the alluvium, yet cassiterite also occurs in various places *in situ* in the rocks of the region. It is most often found in granite, but also occurs in the limestone and sandstone. It has been worked in a few localities, notably in the granite at Sorakai in Perak, and at the Rin mine in the Jelibu district in Selangor, while at Chongkat Pari in Perak, it has been worked in limestone. None of these efforts, however, have as yet been more than partially successful, and most of them have eventually failed, as the ore is in too scattered a condition to pay to work. Hence, though tin is frequently found in the rocks as well as in the alluvium, mining is mostly confined to the latter. It seems not impossible, however, that deposits may yet be found in the rock that can be profitably worked.

Where the tin is seen *in situ* in the granite, it occurs in pockets, small veins, or a combination of stringers intersecting each other in various directions in the form of a network, while

elsewhere the rock is simply impregnated with particles and crystals of cassiterite over certain areas. The tin is associated with quartz, tourmaline, fluorite, and the other minerals already mentioned, especially iron pyrites and arsenical pyrites, which often occur in very considerable quantities, and with smaller quantities of chalcopyrite. At Sorakai, some three miles southwest of Ipoh, two shafts were sunk on small seams of tin ore in the granite by an English company, but operations did not prove profitable and the works are now closed.

Tin in the limestone is probably rarer than in the granite, as

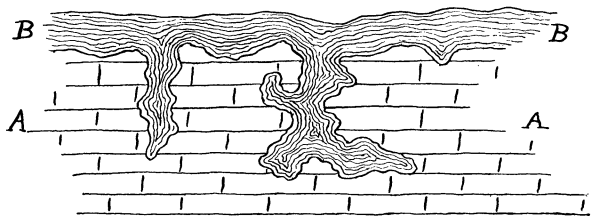


FIG. 4.—Section showing occurrence of tin-bearing alluvium at Chongkat Pari, Perak, Malay peninsula.

Chongkat Pari was the only case seen or heard of by the writer where it had been clearly proved to exist in that rock, while tin in the granite is of common occurrence. Chongkat Pari is two and a half miles southwest of Ipoh, and the region has been extensively worked for alluvial tin. The bed-rock is limestone, and the alluvium occurs in hollows and caves in the leached surface of this rock. (See Fig. 4.) It is from 1 to probably 20 feet in depth, of a reddish-brown color, and contains many large ferruginous masses, probably resulting from the oxidation of iron-bearing sulphides common in the limestone. At the mine of the Leh Chin Tin Mining Co. at this locality tin occurs not only in the alluvium, but also *in situ* in limestone. It is found along a zone of fracturing, marked sometimes by sheeting, running in a general direction of north northeast and south southwest, and dipping steeply to the west northwest. The ore occurs as cassiterite along the zone of fracturing, sometimes as an impregnation in the limestone, sometimes as lenses or irregular pockets from 4 to 24 inches in width, and sometimes along the

cracks in the rock, either longitudinally or transversely with the zone of fracturing. (See Fig. 5.) It is associated with large quantities of iron pyrites and arsenical pyrites, and smaller quantities of chalcopyrite and bornite, with some rhodochrosite. On the surface, limonite and malachite are found in the leached hollows of the rock, having been derived from the oxidation of the iron and copper sulphides. The deposit has been opened by

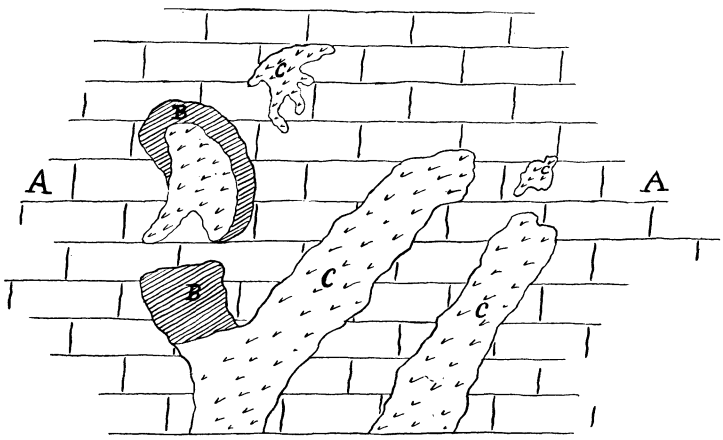


FIG. 5.—Section showing occurrence of tin in limestone at Chongkat Pari, Perak Malay peninsula.

a cut about 20 feet in depth in the limestone, but not much ore has been mined, as it has not yet been found in large quantities.

A few miles southeast of Ipoh, on the road to Gopeng, are a number of limestone hills rising several hundred feet above the valley. On the summits of some of these tin is said to have been found in the soil. It has yet to be determined, however, whether these deposits have been derived by decay *in situ* from tin deposits in the limestone, or whether they are the remains of old alluvial deposits transported there from a distance before the hills were formed. (See Fig. 6.)

At Bruseh, near Tapa, in Perak, tin has been found in thin seams and films along the lines of bedding in a soft, fine-grained, friable sandstone, which bears every evidence of being a comparatively young rock, and it seems probable that the tin in it was derived from tin-bearing solutions from the older rocks

percolating along the bedding planes. This special locality was not visited by the writer, but specimens of the ore and the rock were seen.

Origin of the tin deposits of the Kinta district.—The question of the origin of the tin deposits includes the occurrence of both the tin in the alluvium and the tin in the rock. The tin in the

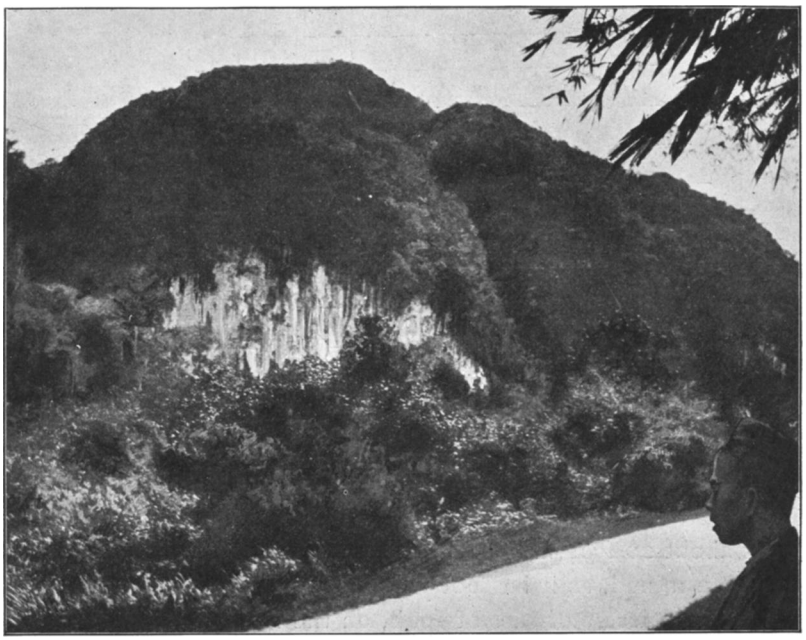


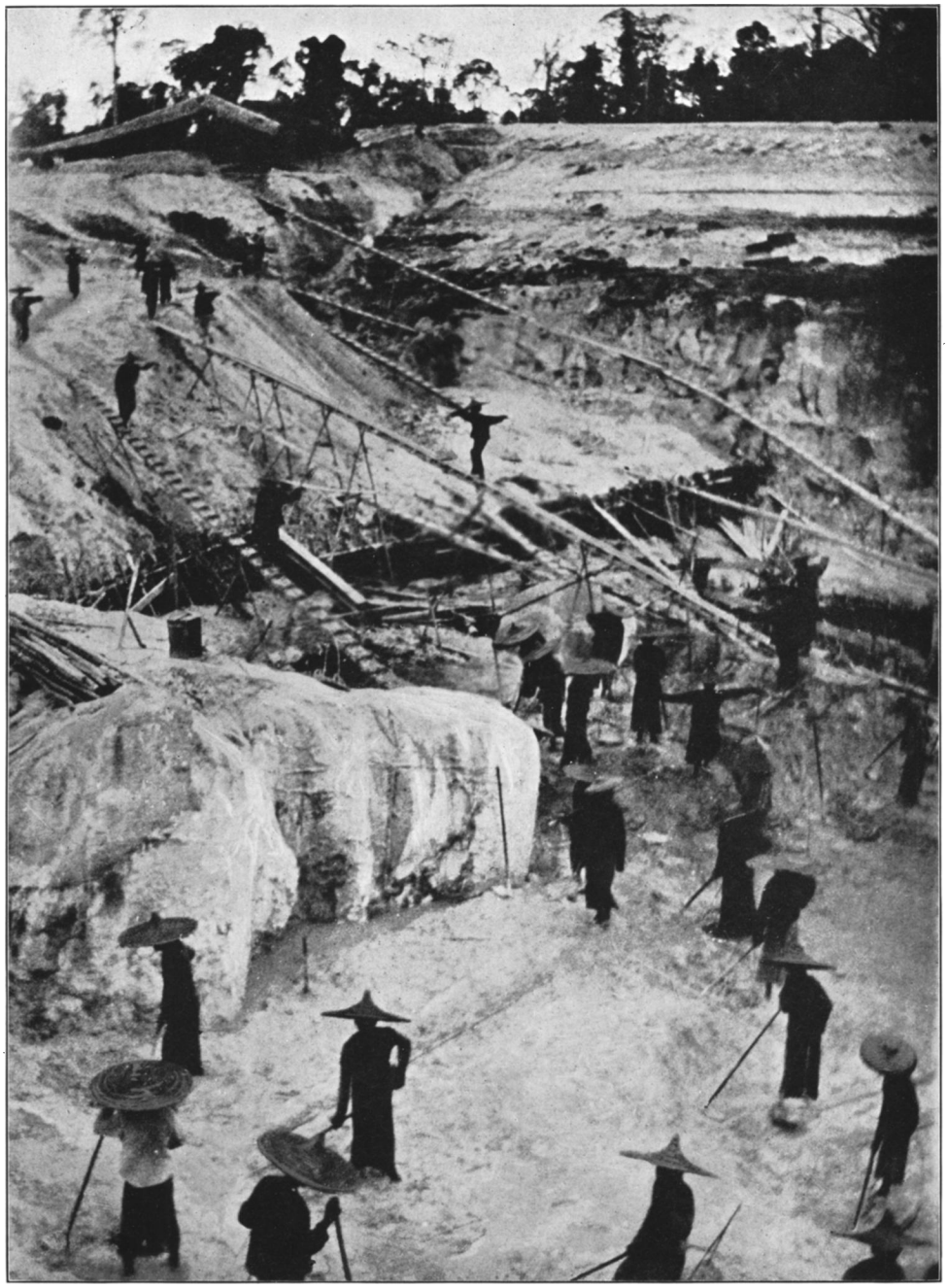
FIG. 6.—Limestone bluffs southeast of Ipoh, Perak, Malay peninsula.

alluvium has clearly been derived by erosion from the tin in the rock, as is proved by the following facts:

1. Tin in noticeable quantities is a constituent of some of the rocks of the region, especially the granitic rocks and sometimes the limestone.

2. The mass of the alluvium is composed of materials derived largely from the decay and erosion of the tin-bearing rocks of the region, and contains numerous pebbles and bowlders of these rocks.

3. Frequently granitic fragments, similar to the granite in



Tin mine near Tronoh, Perak, Malay peninsula, showing limestone bed rock underlying tin-bearing alluvium.

the surrounding hills and carrying cassiterite, are found in the alluvium.

4. The cassiterite in the alluvium, though in a fragmental condition, is of the same character as that in the granite and limestone.

5. The alluvium is as a rule richest in tin, and the fragments of ore are largest, near the areas of tin-bearing rocks.

6. The characteristic minerals associated with the tin in the alluvium are the same as those associated with it in the rock, except in the case of the easily altered minerals, such as the iron and copper sulphides, which have usually been decomposed in the decay of the rocks, and therefore do not often appear in the alluvium, though partly altered masses of these minerals are sometimes found in the alluvium.

Such facts as these leave no doubt as to the origin of the tin in the alluvium. As regards the tin in the rocks, it may be said that in the granite, the occurrence of the cassiterite in veins, stringers, networks, etc., along lines of fracturing, are strong evidences of aqueous deposition of the ore; while the occurrence as an impregnation in the rock where no marked fissuring occurs may be due either to segregation during a more or less molten condition of the rock or to aqueous concentration in a solidified rock. It is possible that the tin was originally a disseminated constituent of the granitic rocks; and in places its concentration may have been due to segregation from a molten mass, but there can be no doubt that some of the concentration, as at present seen, was due to water action after the solidification of the rock.

The tin in the limestone was probably also deposited from solution. It does not seem probable that it was derived mechanically from the erosion of the granite during the deposition of the limestone formation, as it does not occur in the manner of a fragmental deposit, but in seams and clusters along lines of fracturing. Moreover, it is accompanied by iron pyrites, chalcopyrite, arsenical pyrites, etc., just as in the granite, and this would probably not be the case had the tin been detrital, as the iron sulphides in the granite would have been largely decomposed before being enveloped in the limestone. It seems prob-

able, therefore, that the tin in the limestone was deposited from aqueous solution in the same way as at least part of the tin in the granite. It is possible that the tin-bearing waters that deposited the ore in the limestone may have derived their metalliferous contents by solution from the disseminated tin in the granite; and this may account for the rarer occurrence of tin in the limestone than in the granite, for if the latter was the original source of the solutions that deposited tin in both rocks, the granite might get more of the deposition than the limestone, which was less close to the source of the solutions.

The tin found in the bedding planes of the sandstone near Tapa, seems, as already stated, to be a later deposit derived by solution from the older deposits in the granite or limestone.

Commercial features of tin-mining in the Kinta district.— Most of the mines of the Kinta district are operated by Chinamen, and the work is generally crude;[1] but in some localities, like Gopeng and elsewhere, English companies work the mines, while at Campar a French corporation carries on large operations; and in such cases the work is carried on in a more systematic manner. The laborers are mostly coolies from southern China and Indians from the east coast of India. The native Malays do not do much work, and Europeans cannot stand hard work in this climate. The coolies are the most numerous laborers, and here, as elsewhere in southeastern Asia, they are always found where there is any hard work to be done.

The tin-bearing alluvium is worked mostly in open cuts or large pits, except where the covering, or "overburden," of barren ground is very thick, when sometimes shafts are sunk through it to the tin stratum. Most of the workings, especially those of the Chinese, are only very shallow excavations on account of the difficulty of handling the water found at a depth. The average of the Chinese pits is probably not over about 40 feet in depth, though the enterprising Chinese mine-owner, Mr. Foo Choo Choon, reached several times this depth in his mine at Tronoh before he sold it. Some of the more progressive Chinamen

[1] The systematic operations of Mr. Foo Choo Choon, under the management of r. John Addis, are an exception to the usual crude methods of Chinese mining.

have lately introduced pumps to handle water, but even yet it is not uncommon to see the water raised from a shallow pit by a chain of buckets operated by a human treadmill, worked by the feet of two or three men. (See Fig. 7.)

The tin alluvium, after being mined, is carried to the surface in small baskets hung on both ends of a stick suspended on a

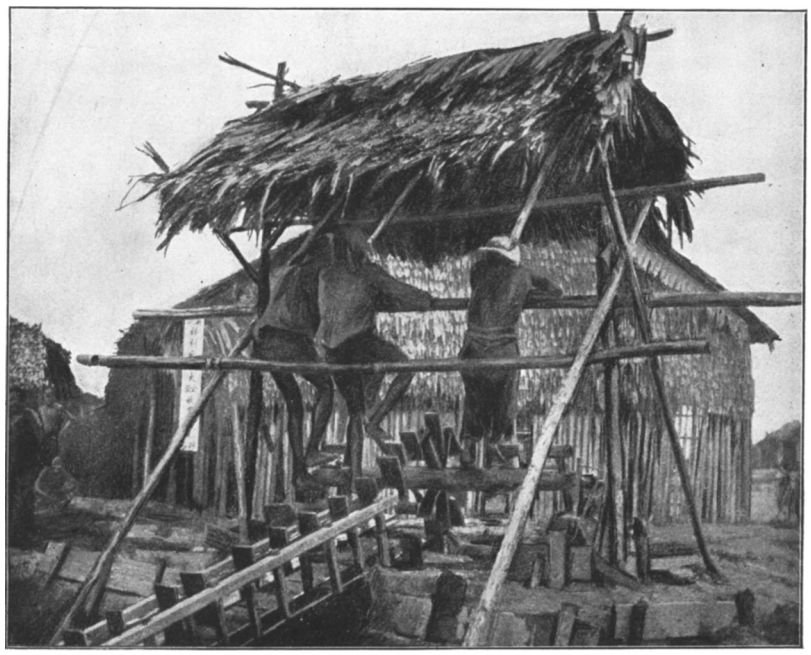


FIG. 7.—Pumping water by human treadmill, near Lahat, Perak, Malay peninsula.

Chinaman's back. It is then dumped into wooden troughs supplied with a stream of running water, where, if there is much clay present, it is stirred with shovels and hoes to separate the tin ore. If there is no clay or only a little of it present, the "tin dirt" is simply dropped into the trough in the running water. The materials are carried thence by the water into sluices, where the cassiterite and other heavy minerals sink to the bottom, and the sand, clay, and lighter materials are carried away by the stream. (See Figs. 3 and 8.) The sluices may

range from a few feet to several hundred feet in length, as the case may require, and are either made of wood or are cut in the sandy clay of the region. After a certain number of hours, the stream is stopped and the material at the bottom of the sluice is still further concentrated by hand panning in a flat wooden bowl not unlike in shape the ordinary sheet-iron American gold pan.

FIG. 8.—Washing tin ore near Tronoh, Perak, Malay peninsula.

(See Fig. 9.) The final process in the preparation of the ore is the separation, by hand-picking or by very expert panners, of the particles of magnetite and other heavy minerals associated with the tin, finally leaving a product varying from 69 to 73 per cent. in metallic tin. This ore is then sacked and hauled to market.

At Gopeng, the Gopeng Tin Mining Co. is using hydraulic monitors to handle the alluvium, in the same way as they are used in the gold placers of California. At Cacha, an English company has also erected a stamp mill with concentrating tables to crush and concentrate masses of ore. The alluvium here has

Eroded limestone surface in tin diggings between Ipoh and Lahat, Perak, Malay peninsula.

often been indurated by infiltration of iron compounds, while it also often contains masses of the original tin-bearing rock from which the cassiterite has not yet been liberated, so that crushing becomes necessary. At Sorakai, roasting, crushing, and concentrating machinery has been introduced by the Sorakai Tin Mining Co., an English corporation, to handle the ore mined in the

FIG. 9.—Women washing tin ore near Lahat, Perak, Malay peninsula.

granite at that locality, the roasting being necessary to drive off the arsenic in the ore. At Tronoh, some of the alluvium contains much clay which adheres closely to the tin, and the material is treated in large tanks with revolving paddles inside.

The tin was formerly smelted largely at local works in the various mining districts, and some of it is still treated in this way, but most of it is now smelted by the Straits Trading Co., which has a large smelting plant at Singapore. This company has great influence throughout the peninsula, and has established numerous agencies where tin is bought from the miners and sent to Singapore. The total production of tin on the Malay penin-

sula in 1901 was almost 47,000 tons, which is over half the tin of the world, while the production of the peninsula and the islands of Banka and Billiton together amounted to over three-quarters of the production of the world.

The tin lands on the peninsula are either bought or leased, and the government of the Federated Malay States imposes an export tax on tin ore of about 12 per cent. of its value. As tin is the main product of the peninsula, the tax affords a large income, which is the principal support of the government. The money derived from this source has been wisely expended, generally under British advice, in internal improvements. Excellent wagon roads have been built throughout the different states, and railways have been constructed in a number of localities. As yet the latter have not been connected throughout the peninsula, as they are being extended only so fast as funds are obtained to build them. It is expected, however, that before long the isolated lines of railway will be extended, so that there will be continuous connection from the extreme southern end of the peninsula at the town of Johor to the Siamese boundary on the north.

R. A. F. PENROSE, JR.

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